451-WDISC-PMP 98

NETWORKS AND MISSION SERVICES PROJECT

WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Project Management Plan (PMP)

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National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Section 1. Introduction

1.1 Purpose of Document

This document presents a plan to be used by NASA to identify, evaluate, and implement a White Sands Complex (WSC) Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC). The WDISC will enable customers at Mission Operation Centers (MOCs) to receive telemetry data and send commands using TCP/IP protocol via the Closed IP Operational Network (IONet). This document addresses the elements associated with implementing this system including:

a. Background
b. Project Objective
c. Approach
d. Roles and Responsibilities
e. Resources Required
f. Schedule & Interdependencies
g. Risk and Mitigation Actions.

1.2 Background

NASA Integrated Services Network (NISN) provides data transport services between the WSC and customer MOCs. NISN has sought to reduce infrastructure costs by replacing the current 4800-bit-block point to point serial network with an IP based system. For legacy customers, the 4800-bit-blocks will be encapsulated into User Datagram Protocol (UDP)/IP packets.

Customers are now requesting TCP/IP data services for the communications between the ground terminal and customer facilities. While a common approach to respond to the need of these potential Space Network (SN) customers is being studied, NASA has been providing for unique implementations for the near-term missions. As examples, full support SN customers such as EOS AM-1 and Landsat 7 are installing custom interfaces at the WSC. Currently, future low data rate, limited support SN customers have been requesting total TCP/IP supported data services. The initial customer set includes New Millennium Program Earth Orbiter-1 (NMP/EO-1), Far Ultraviolet Spectroscopy Explorer (FUSE), and Gravity Probe B Relativity (GP-B).

To provide customers with a full range of TCP/IP services, the WDISC is being designed to allow customers to request forward service, confirmations, commands, and telemetry via TCP/IP on the closed IONet, where communications are limited to a defined set of authorized addresses.

The majority of the WDISC features are planned to be consistent with the Consultative Committee for Space Data Systems (CCSDS), an international organization of space agencies interested in mutually developing standard data handling techniques to support space research, including space science and applications. WDISC will provide the customers with many of the CCSDS space link functions such as frame synchronization, randomization/derandomization and RS decoding. A future enhancement may be to incorporate the CCSDS Space Link Extension (SLE) services into the system.

1.3 Objective

The overall objective of the WDISC effort is to provide direct TCP/IP based telemetry and command services on the closed IONet from the WSC. By combining the requirements of several unique customers and applying knowledge of heritage systems and customers, NASA plans to leverage the commonality to design and allow for future enhancements to provide support for a variety of customers. This capability is geared toward the new SN customers, initially EO-1 and GP-B, not using the existing 4800-bit-block infrastructure. Specific strategies in support of this objective include:

a. To support testing and operational phases of the EO-1 and GP-B missions.

b. To ensure that the design allows for, to the extent possible, future expansion and enhancement.

c. To provide data services without requiring the need for mission unique equipment at WSC.

d. To incorporate and evolve SN support of CCSDS standards and services.

1.4 Approach

The general approach is described in seven distinct steps:

1. Project Planning and Requirement Compilation
2. Vendor Proposal Analysis
3. Programmable Telemetry Processors (PTP) Procurement Process
4. WDISC Project Review and Operations Concept Development
5. PTP Configuration and Testing at GSFC
6. Equipment Shipping and Installation at WSC
7. Acceptance Testing and Transition to Operations.

1. Project Planning and Requirement Compilation - The initial effort consists of establishing a consolidated list of system requirements based on customer needs. These requirements will be identified and compiled based on the initial customer set including NMP/EO-1 and GP-B. This effort will take into account WSC and TCP/IP capabilities and constraints. A requirement document will be written, distributed, and placed under configuration control via the Space Network/Code 451 Configuration Control Board (CCB).

2. Vendor Proposal Analysis - The requirement specification will be given to the PTP vendor (AvTec) who will respond with a detailed proposal. The project team will then perform an analysis of this proposal.

3. PTP Procurement Process - Once there is confidence that the proposed product will meet the requirements specified, procurement of the PTPs will begin. The minimum time to procure the PTPs is 2 months out of the overall project schedule of 6 months; therefore, the procurement process must be initiated prior to the design review. The SEWP contract will be used to procure the PTPs resulting in a lower cost and a faster procurement schedule. Maintenance requirements will also be addressed during this phase.

4. WDISC Project Review and Operations Concept Development - Prior to PTP configuration and testing, a WDISC Project Review will be held at Goddard Space Flight Center (GSFC). This review will include all interested parties. In preparation for this review, an operations concept will be developed to assist the customers and developers with the final design and implementation. The operations concept will describe the general operations including local and remote control, operational capabilities, and contingency management. The design review will also include descriptions of the physical configuration, performance requirements, hardware and software, and testing and transition to operations planning.

5. PTP Configuration and Testing at GSFC - The PTPs will then be configured and tested at GSFC. The Bit Error Rate Test System (BERTS) test module will be utilized. Mission test data will be used if available. Efforts will be made to perform integrated testing with customers' testing facilities. Test plans and procedures will be generated to support this effort. Test reports will reflect verification of system requirements for segment completion.

6. Equipment Shipping and Installation at WSC - Upon satisfactory testing, the PTPs will be shipped to WSC to be interfaced with the local interfaces at both White Sands Ground Terminal (WSGT) and Second TDRSS Ground Terminal (STGT).

7. Acceptance Testing and Transition to Operations - Standard system and acceptance testing at WSC will complement the previous testing and validate the systems compatibility. A SN Test Report will be completed for acceptance testing to document post-test evaluation and data analysis. This report will outline SN test objectives and the completion of these objectives to determine if retests are required. A Test Requirement Verification Matrix (TRVM) may also be needed to verify the system requirements for project completion. A User's Guide, or documentation outlining the procedures to operate this equipment, will be provided. An operational readiness review will be held to ensure the system's compatibility with the Network and the customer systems.

1.4.1 Periodic Reporting and Security

Periodic reporting will also document the progress of this effort. Weekly status will be provided to NASA management and summarized at the Monthly Status Reviews (MSR).

The project will conform to policies, standards, and procedures in accordance with Automated Information Systems Security (AISS) Program.

1.4.2 Concept Architecture

This interface is planned to be established by installing redundant PTPs at WSC. The reference architecture consists of closed IONet, PTPs, and MOCs. Located at WSC, PTPs will framesync and decode data and send via TCP/IP to the customers. Figure 1-1 depicts WDISC Initial Architecture Concept. This is only the preliminary concept.

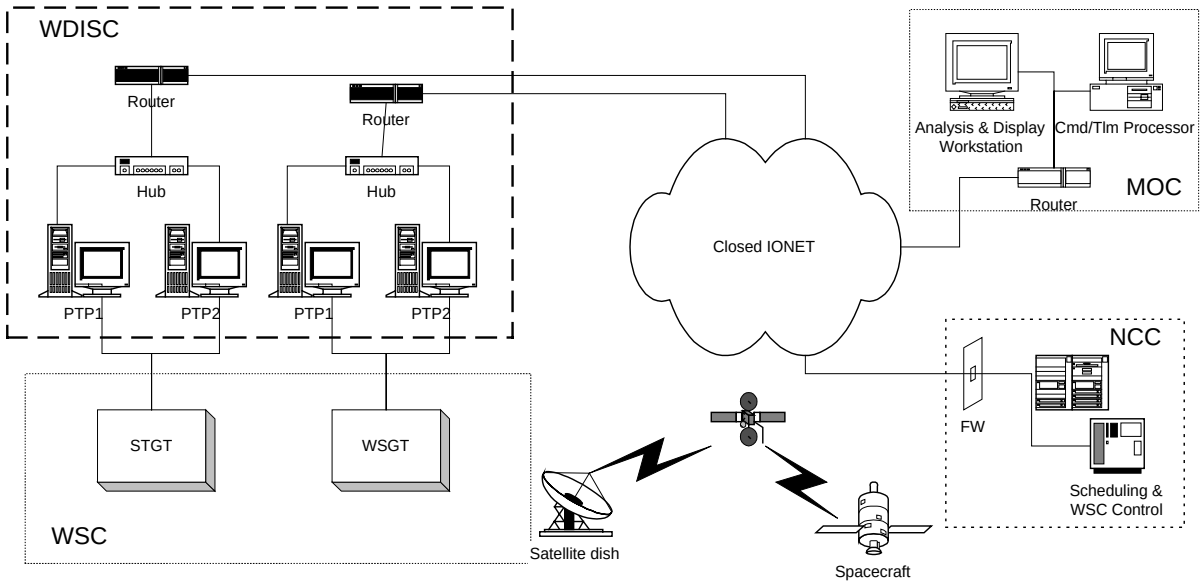

Figure 1-1. WDISC Reference Architecture Concept

1.5 Reference Documents

The following documents are considered reference materials, which have relevancy to this document:

a. *Detailed Mission Requirements (DMR) Document for the Gravity Probe-B Mission (GP-B),* April 16, 1998, 450-215/GP-B.

b. *Detailed Mission Requirements (DMR) Document for the New Millennium Program Earth Orbiter-1 (NMP/EO-1),* March 30, 1998, 450-215/EO-1.

c. *EO-1 Spacecraft to Ground Interface Control Document*, Version 2, March 26, 1998, No Identifier.

d. *Requirements Specification for the White Sands Complex (WSC),* Revision 1, June 1, 1997, 530-RSD-WSC.

e. *Space Network (SN) User's Guide*, Revision 7, November 1995, 530-SNUG.

f. *Programmable Telemetry Processor for Windows NT (PTP-NT),* User's Manual Version 1.0, June 1997, No Identifier.

g. *NASA Communications (Nascom) Programmable Telemetry Processor (PTP) Installation and Troubleshooting Guide*, November 1996, No Identifier.

h. *Interface Control Document (ICD) Between the Network Control Center (NCC)/Flight Dynamics Facility (FDF) and the White Sands Complex (WSC)*, Revision 5, June 1, 1998, 530-ICD-NCC-FDF/WSC.

Section 2. Roles and Responsibilities

2.1 GSFC Support

The Code 451, Space Network Systems Engineering Team has been developing a strategy for the evolution of Network and Mission Services (N&MS) IP data services with input from the Space Operations Management Office (SOMO) and NASA's customers.

The Project Manager, Reine Chimiak, is responsible for all aspects (such as cost, schedule, and technical elements) associated with WDISC system development.

Space Network System Manager, Dave Littmann, is responsible for maintaining overall cognizance for SN system engineering activities. He will support requirements and project reviews, provide technical interfaces with customers and Code 450 Mission Managers, and oversee this effort in conjunction with other major Space Network activities.

NCC System Manager, Roger Clason, will provide support to resolve any issues involving the NCC, and coordinate any NCC modifications or additions. These may include new interfaces such as remote control of the PTPs via the NCC or additional schedule requirements.

The SN Mission Managers will coordinate new user requirements such as database changes.

NISN Project Engineer, Chris Spinolo, will provide support for NISN coordination at WSC.

Computer Science Corporation (CSC) will provide engineering support with the requirement generation, development, and test support of the PTP at GSFC.

Booz, Allen & Hamilton will provide technical and management project planning support.

AlliedSignal Technical Services Corporation (ATSC) will provide any customized software required to interface the PTPs with the NCC or other elements. A remote control interface may be added to the standard set of PTP's features to accommodate proposed procedures.

2.2 WSC Support

WSC System Engineer, Bryan Gioannini, will assist with defining the operational concept, requirements, and interfaces at WSC.

WSC Systems Engineer, Jim Edgington (ATSC), will provide a point of contact for WSC Systems Engineering activities. He will assist with design and implementation issues for the WSC Engineering Change (EC) development, approval, scheduling, implementation, as-built documentation, and software database change coordination.

WSC Technical Operation and Analysis (TO&A) personnel will support any network test activity associated with this effort and support mission integration tests.

2.3 Customer Support

Documentation and support for the two initial missions to be supported via the WDISC, NMP/EO-1 and GP-B, are being provided by Larry Phillips, Mission Manager for GB-P, Paulino Garza, Mission Manager for EO-1, and Roberto Rodriguez/ATSC.

2.4 Configuration Management Support

Code 451, SN CCB will be used for configuration management of the WDISC requirements. All other documentation shall be controlled by the WDISC Project Manager.

Section 3. Resources

This section outlines the overall resource estimates for the performance of the tasks.

3.1 Budget

The total budget allocated to this implementation will be $250,000 including technical contractor labor and hardware. Hardware will include rack mounted PTPs with consoles and keyboards. The hardware budget is dependent upon the design concept. A cross strapping architecture is being considered to reduce the number of PTPs required from four to two while maintaining reliable support.

3.2 Equipment Description

Provided by AvTec Systems, the PTPs are PC-based, multi-channel telemetry and command front-end processors. Standard Personal Computers (PCs) will be used, equipped with two AvTec (Monarch or AT-HSI02) boards and Time boards. The PCs will be also equipped with Ethernet interface, Small Computer System Interface (SCSI) and IDE disks, and a CD ROM drive. The PTP NT Server controls the PTP hardware and performs all of the real-time data processing.

The data rates needed will dictate the type of boards the PTPs require. The two missions identified do not require high performance boards; however, it is reasonable to expect future missions to require high data rate performance. High performance boards support data rates up to 25 Mbps. The standard boards cost nominally less.

Software control is a Graphical User Interface (GUI) under the Windows NT operating system. Windows NT supports multi-threaded applications and symmetric multi-processing. The PTP's design will provide customers with unique support and allow for a variety of applications. At a high level the following are features of the PTP system:

a. Telemetry and Command Gateway for satellite control

b. Network remote control, monitoring, and data transfer

c. Interfaces with COTS ground control software

d. Data Quality Monitor (DQM)

e. Bit Error Rate Tester (BERT)

f. Data logging and playback to/from hard disk

3.3 High Availability (HA)

A redundancy scheme is based on the current data flow concept. In this description, the PTP acts as a TCP server and the end user is a TCP client. The two PTPs are both receiving data as shown below:

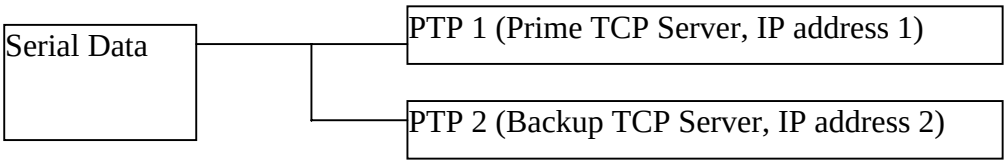

Figure 3-1. High Availability Flow Diagram

The PTPs are configured with the same desktop. The client attempts to connect to PTP 1. If the connection fails or if the client cannot read any data for a specified time-out period, then the client attempts to connect to PTP 2.

A customized automated high availability capability is being studied; however, this may require a significant amount of custom code, and may not be attainable in the initial phase of WDISC because of schedule constraints.

3.4 Software Development

Custom developed software is required for external control of the PTPs. A client / server methodology is used in the design of this system. For starting and stopping desktops, the server side of the PTP timer is a multi-threaded server. The server will accept data related to a scheduled event and starts a thread for each event. The thread will load, start, and stop the appropriate desktop on the PTP at the times designated in the received data to control the event.

The client side of the PTP timer is primarily a user interface and a socket for communicating with the server. The client will be capable of the following:

1) Prompt the user for event information
2) Validate the information
3) Transfer event information to the PTP timer server.

Section 4. Schedule and Interdependencies

The schedule uses the Program Evaluation Review Technique (PERT) to document interdependencies.

The primary requirement that drives the schedule is to provide support to NMP/EO-1 and the GP-B missions 6 months before launch. The schedule has been created to support the following launch dates:

- NMP/EO-1 launch date is May 27, 1999.
- GP-B launch date is early 2000.

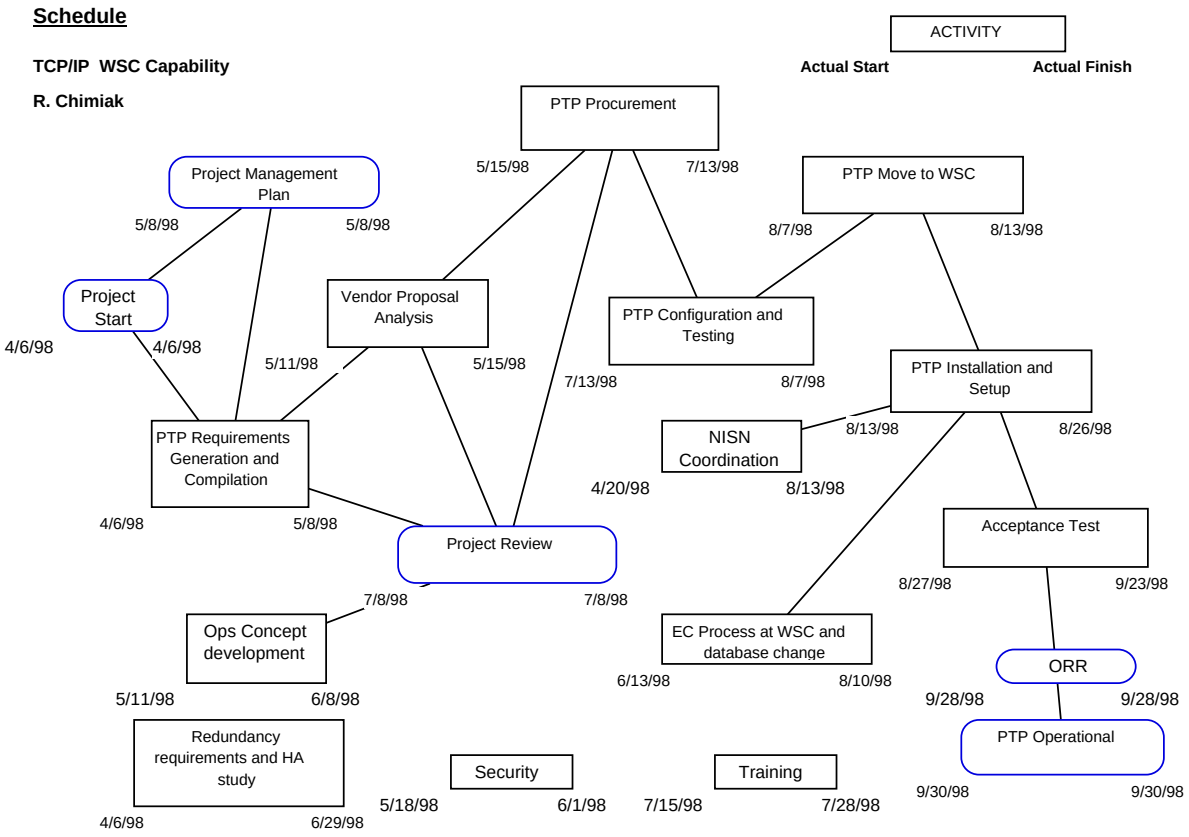

Figure 4-1. WDISC PERT Diagram

Section 5. Risk and Mitigation

The following outlines the risks identified early in the project planning and the actions required to mitigate these risks.

Table 5-1. Risk and Mitigation Action Table

Risk	*Mitigation Action*
1) Events are scheduled on a success-oriented template with little contingency available.	The schedule shows the project ending at the end of September 1998. The operational readiness date could be extended for 2 months and still meet the NMP/EO-1 requirements.
2) Without a working PTP model, it is difficult to determine if all of the requirements can be met.	NASA will provide detailed requirements to AvTec ahead of schedule.
3) The software maintenance contract has not been finalized.	AvTec provides a 1-year maintenance contract with extensions available within the warranty. Work with AvTec to agree on maintenance requirements and develop a contingency plan to maintain the systems.
4) PTP Y2K.	PTPs are being delivered with Windows NT 4.0 Service Pack 3 which is compliant. A program has been procured to test and certify the software with the BIOS code.
5) The initial mission requirements could change after NASA has finalized the requirements.	NASA will order PTPs with enough capability to be functional with other missions. Unless the requirements changes are significant, the PTPs that are ordered should be versatile enough to allow changes.
6) High availability software needs to be identified.	There will be dual machines with same capabilities in case one is unavailable. Research is required to determine if automatic HA is feasible and required to meet availability specifications.

Abbreviations & Acronyms

ATSC	AlliedSignal Technical Services Corporation
BA&H	Booz, Allen & Hamilton
BERTS	Bit Error Rate Test System
CCSDS	Consultative Committee for Space Data Systems
COTS	Commercial Off-The-Shelf
CSC	Computer Science Corporation
DAS	Demand Access Service
DMR	Detailed Mission Requirements
DQM	Data Quality Monitor
EC	Engineering Change
EOS	Earth Observing System
FUSE	Far Ultraviolet Spectroscopy Explorer
FW	Firewall
GP-B	Gravity Probe B
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
HA	High Availability
IDE	Intelligent Drive Electronics
IF	Intermediate Frequency
IONet	IP Operational Network
Mbps	Megabits Per Second
MOC	Mission Operations Centers
N&MS	Network and Mission Services
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
NCC	Network Control Center
NISN	NASA Integrated System Network

NMP/EO-1	New Millennium Program Earth Orbiter-1
PC	Personal Computer
PERT	Program Evaluation Review Technique
PSK	Phase Shift Keying
PTP	Programmable Telemetry Processors
SCSI	Small Computer System Interface
SN	Space Network
SOMO	Space Operations Management Office
SLE	Space Link Extension
STGT	Second TDRSS Ground Terminal
TCP/IP	Transmission Control Protocol/Internet Protocol
TO&A	Technical Operation and Analysis
UDP	User Datagram Protocol
WDISC	WSC Data Interface Service Capability
WSC	White Sands Complex
WSGT	White Sands Ground Terminal
Y2K	Year 2000 Compliance